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The Cryosphere Discussions

Interactive comment on "Numerical modeling of permafrost dynamics in Alaska using a high spatial resolution dataset" *by* E. E. Jafarov et al.

Anonymous Referee #1

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The manuscript "Numerical modeling of permafrost dynamics in Alaska using a high spatial resolution dataset" by Jafarov et al. describes transient simulations of the ground thermal regime of permafrost in Alaska for the coming century. With few exceptions, the manuscript is well structured and clearly written. In general, the employed permafrost model is adequately documented (see major comments for the one exception), and the results are well presented. All in all, very good work, which I recommend for publication in the The Cryosphere.
I have a few comments that I would like the authors to consider before publication:

Major comments:

1. Ground thermal parameters:
   p.97, l.13: Getting the thermal ground properties right, is one of the most crucial points for successful modeling of subsurface temperatures. It therefore deserves more than five lines. Please specify: a) What are the physical variables provided by your basis data sets? b) How do you obtain the heat capacity, thermal conductivity and freezing depression from this basis information (which parameterization/classification is used)?
   For example, organic layers should be of crucial importance in Alaska, (how) are they included?
   Later, the authors describe an optimization procedure for AOL under "Sensitivity analysis". I think, the context between these two sections should become clearer, as they ultimately deal with getting subsurface thermal properties right.

2. language: please go through the manuscript, and check the articles before the nouns. There are a lot of places, where the article is missing, e.g. p. 104, l.24ff: "However, the bias in THE climate model simulation of precipitation still remains high, THE correlation between GCMs and observations is .."
   Also, check the language in general.

Minor comments:

p. 90:
l.8 ff: "Input parameters, ..." awkward sentence, please rephrase.
l. 14: Why are your results "preliminary"?
l.19: CALM must be explained when mentioned for the first time.

p.92:
This section is too detailed for the Introduction. It should be deleted or moved to the

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corresponding sections.

p.93:
1.1: I would include this part in the Introduction, not in a specific section 1.1.

p.94:
Eq.1: It should be indicated somehow that the time dependence in H is actually contained in “t”.
Eq.1: be consistent with the use of the gradient/divergence operators. Either “div ... grad”, or use the del/nabla operator twice. Since you are in 1D, I find it even preferable to use partial derivatives.
l.20: volumetric unfrozen water content is unitless.

p.95:
Eq. 6: There must be a relation between t*, a, and b in order to make the function continuous at t*. So, one parameter is redundant.

p.97:
l. 7: initialization: I like that approach!
l.13: see major comment on ground thermal parameters

p.99:
l. 9: Better: “Fig. 5 demonstrates that measured and modeled temperatures agree within 1 degree”.

p. 100:
l. 11 ff: It should be mentioned in one sentence that the agreement for ALT is not

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optimal. I fully agree with the following discussion of the reasons. This highlights again how important a proper documentation of the employed data set for subsurface properties is (see major comment), as future progress in AL modeling will mainly depend on improved data sets.

p. 102:
l.13: “If assigned ...”: please rephrase

p. 101:
5 Model sensitivity analysis: I don’t really think that it is a sensitivity analysis what the authors describe here. Rather: Optimization of ground thermal parameters.

p. 103:
l. 6: emphasizes

p. 105:
l.4: replace high oder by strong

l. 18: How would you include the effect of the forest fire in such a model? Especially, based on which data set/information would you determine when (or with which probability) a forest fire occurs?

p. 106:
l. 9: Is there any indication in literature, that convective heat transfer through ground water movement could play a role on such large distances as 1km? If yes, please cite!
l. 11: The first step might be to have a 1D hydrological model to improve the annual

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dynamics of soil water contents and thus subsurface thermal properties. I'm not sure whether a 3D- hydrological model on a 1km grid would make much sense in many areas, considering the strong variability on much smaller distances. And again, such a model is only as good as the subsurface data sets that flow into it.

p. 117: How many of these boreholes were used to infer the initial temperature profile for the different geothermal zones? Is it possible that part of the good agreement (especially for deep temperatures) is due to the initialization with measured data from these boreholes?

p. 121: I have trouble seeing the difference between the two figures. Maybe better one map for temperatures with additional organic layer, and one map showing the difference?

p. 123: Can you draw a smoothed 0 degree-iso-lines in the maps? This would increase the visual impact of this important figure.

p. 124: Although clear, the abbreviations BR, HV, etc., should be explained in the figure caption.

Interactive comment on The Cryosphere Discuss., 6, 89, 2012.